Pixel Module Presentations

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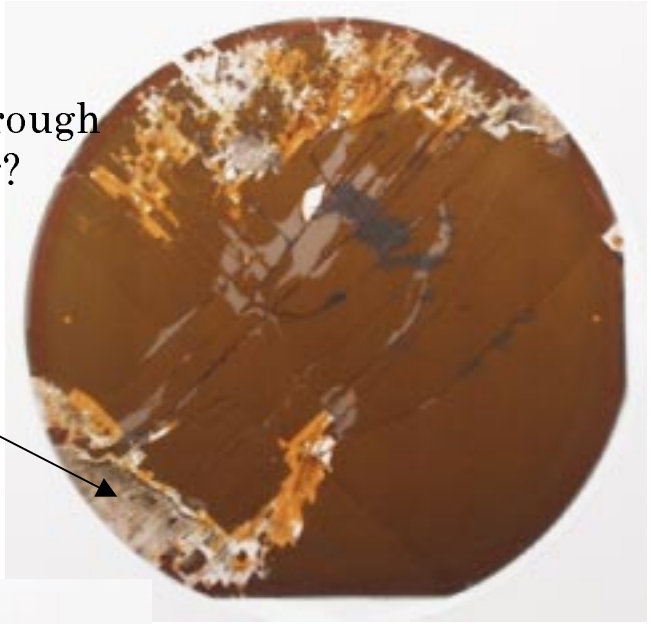
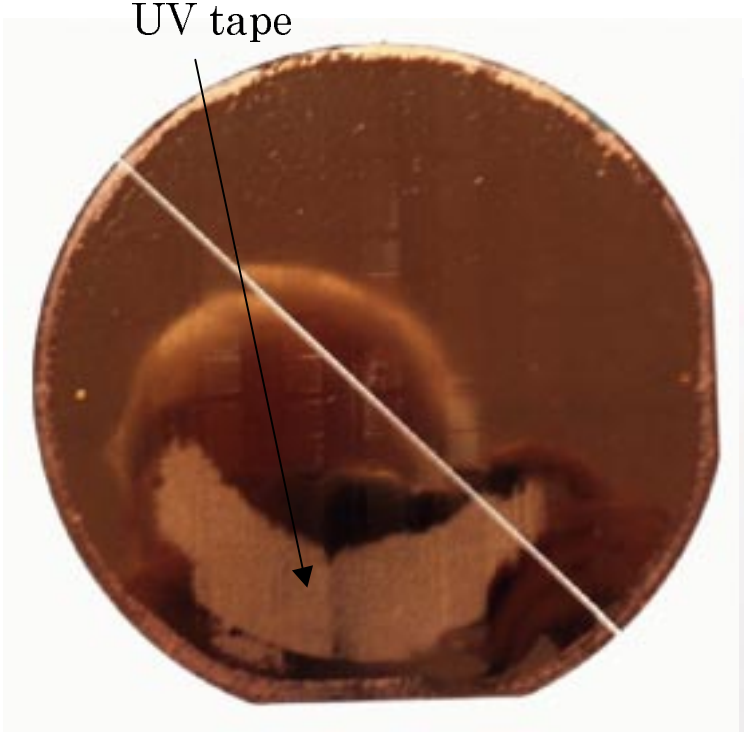
Thin IZM Wafers with Photoresist

Dummy bumped wafers IZM photoresist coating to protect wafers. Did not work well.

150 micron. Region ground through to photoresist. Uneven coating?



200 micron. Cracked by me. Notice patch of interaction with UV tape



250 micron. Large region of interaction with UV releasing tape.

Other results here

- Will have other wafer results Monday/Tuesday

Precision Dicing

- How accurately can IC die be cut?
- Tried this with FE-B wafer Alenia bumped.
- Based on small sample, rms accuracy of 5 microns possible
- But this vendor much too expensive!
- Can normal dicing vendor do this?
- Don't know yet. Some dicing machines capable but requires rigorous QC.

Background

Alenia bumped FE-B wafer fragement sent to MTI for precision dicing. They used 4 mil blade. They screwed up and cut through some die but most were recoverable.

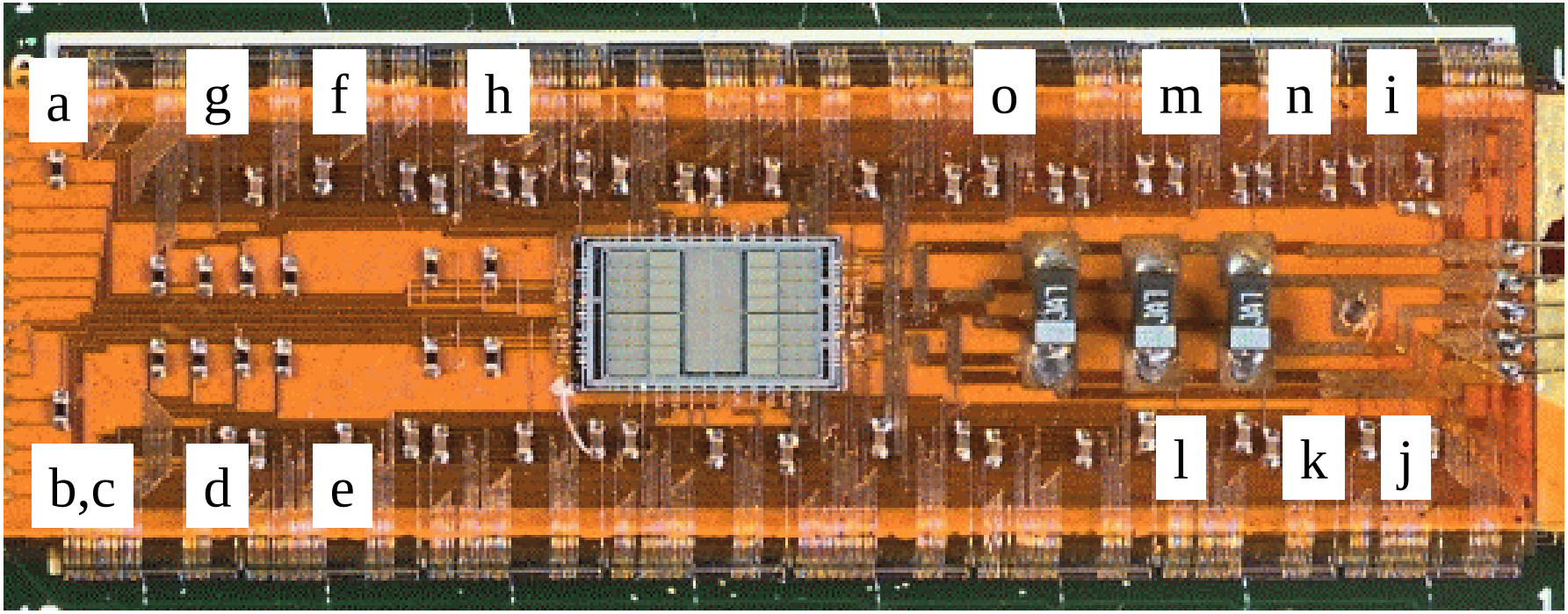
Results

Measured die size with SmartScope, single measurement at each corner. In some cases there is significant chipping along edges and at corners. Nominal as cut size is 7.4 by 11.0 mm. Results of measuring 10 die are shown below.

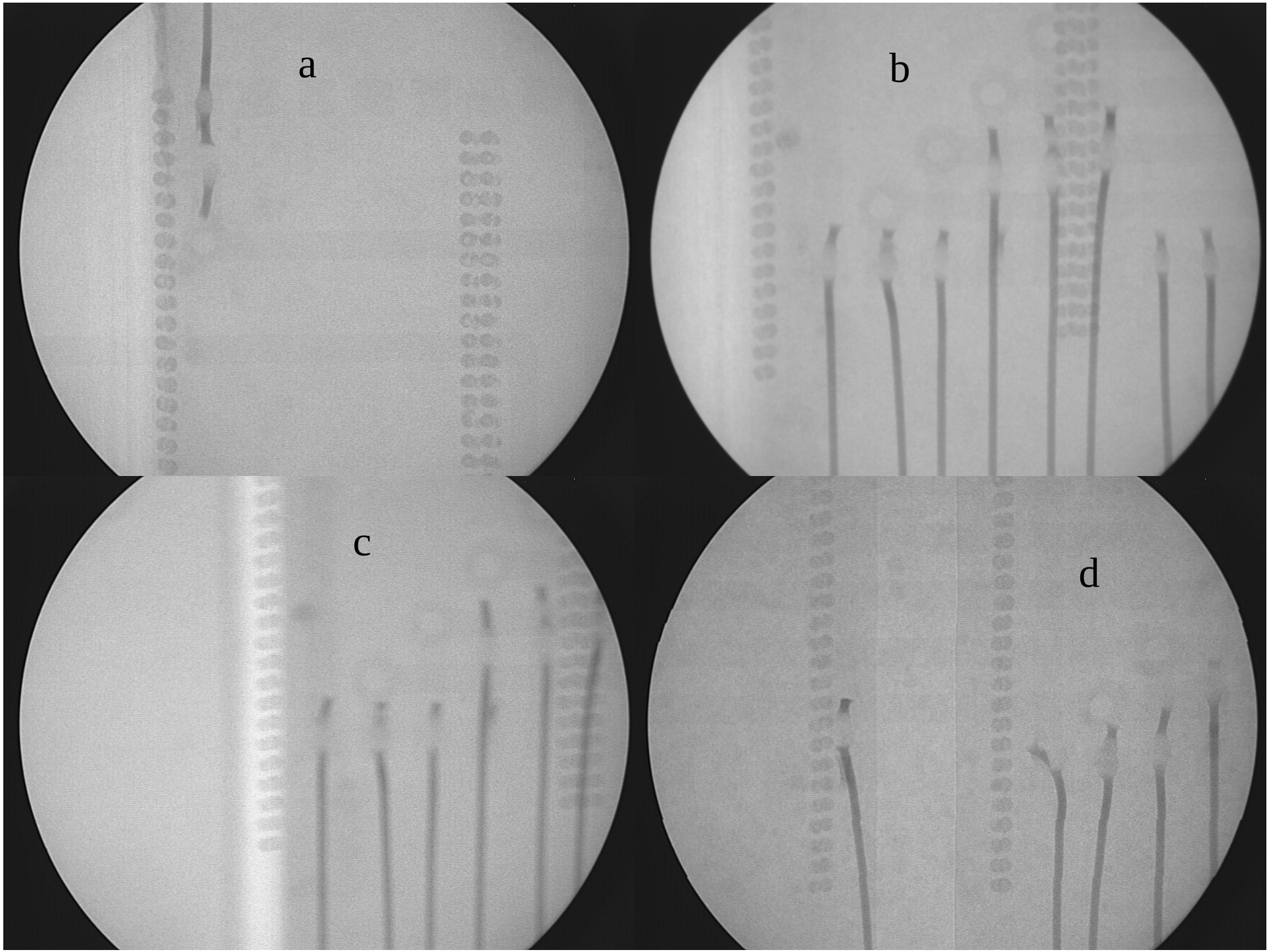
Die	x	y	x	y	x	y	x	y
1	-0.001	0	10.9984	0	11.0054	7.3999	0	7.3968
2	0	0.003	10.9983	0	10.9959	7.4011	0.0026	7.3951
3	0.0001	0.001	10.9989	0	11.007	7.3988	0.0016	7.3978
4	-0.0019	0.0031	11.0025	0	11.0055	7.3983	0.0092	7.405
5	-0.001	0.001	10.9944	0	11.0039	7.3963	0.0065	7.3962
6	-0.001	0.001	11.0022	0	11.0007	7.3998	0.0025	7.4017
7	0	-0.001	11.0066	0	11.0078	7.3988	0.0113	7.4024
8	-0.001	0.001	11.001	0	10.9966	7.4036	-0.0034	7.4006
9	0.0008	0.004	10.9921	0	10.991	7.4031	0.0051	7.4019
10	0.001	0.002	10.9971	0	11.0004	7.3976	0.0062	7.3987
Average	-0.0004	0.00151	10.9992	0	11.0014	7.39973	0.00416	7.39962
Spread	0.0029	0.0050	0.0145	0.0000	0.0168	0.0073	0.0147	0.0099
RMS	0.0009	0.0015	0.0042	0.0000	0.0055	0.0023	0.0044	0.0032

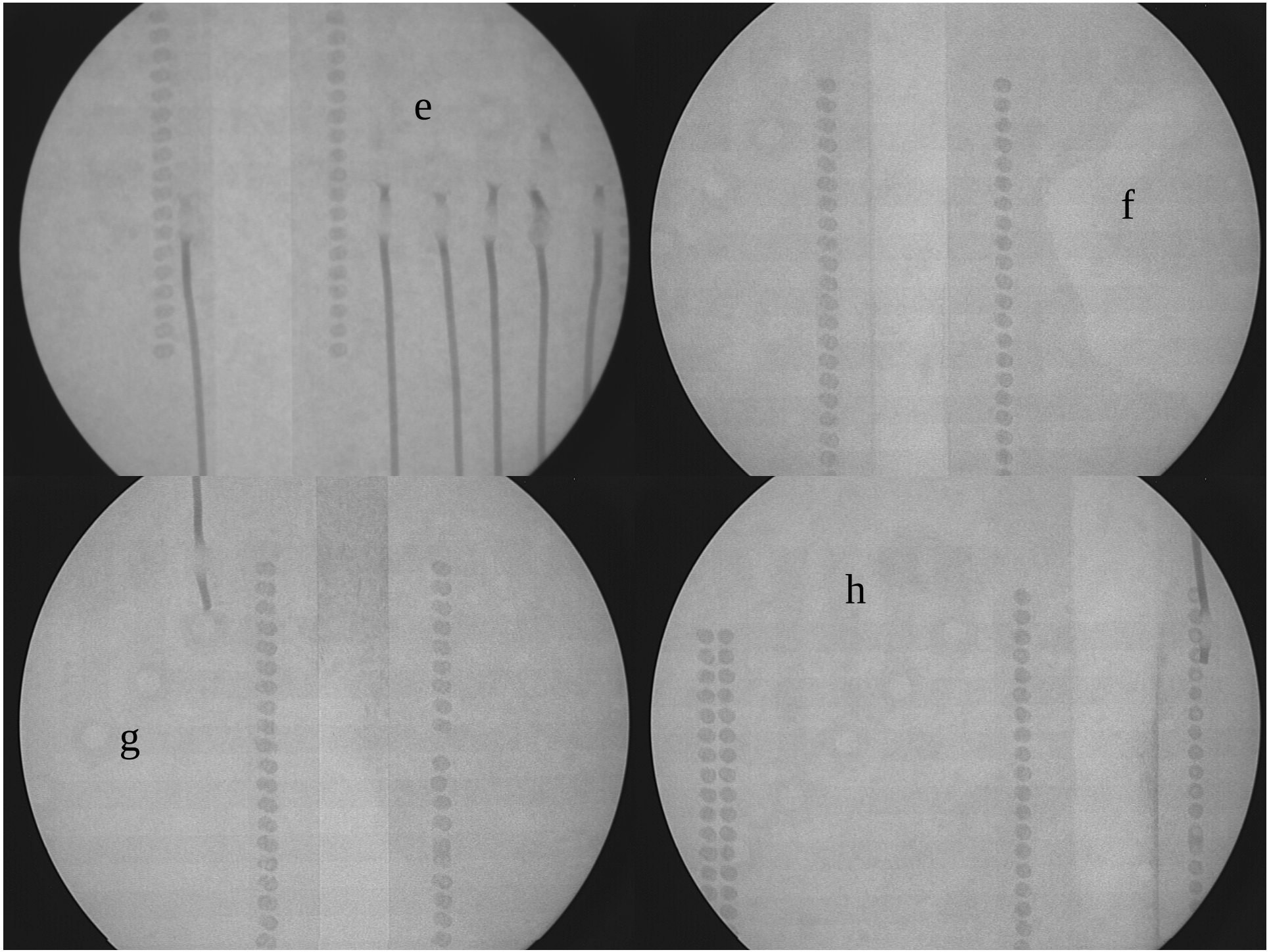
First x-y column shows remeasurement of 0,0 coordinate and gives indication of repeatability of measurement. The spread is the maximum extent - the maximum window. Conclusions are: (1) as cut size on average is dead on desired value; (2) rms is generally within expectations(5 microns); and (3) spread is < 20 microns, probably better. In short, this is precision dicing.

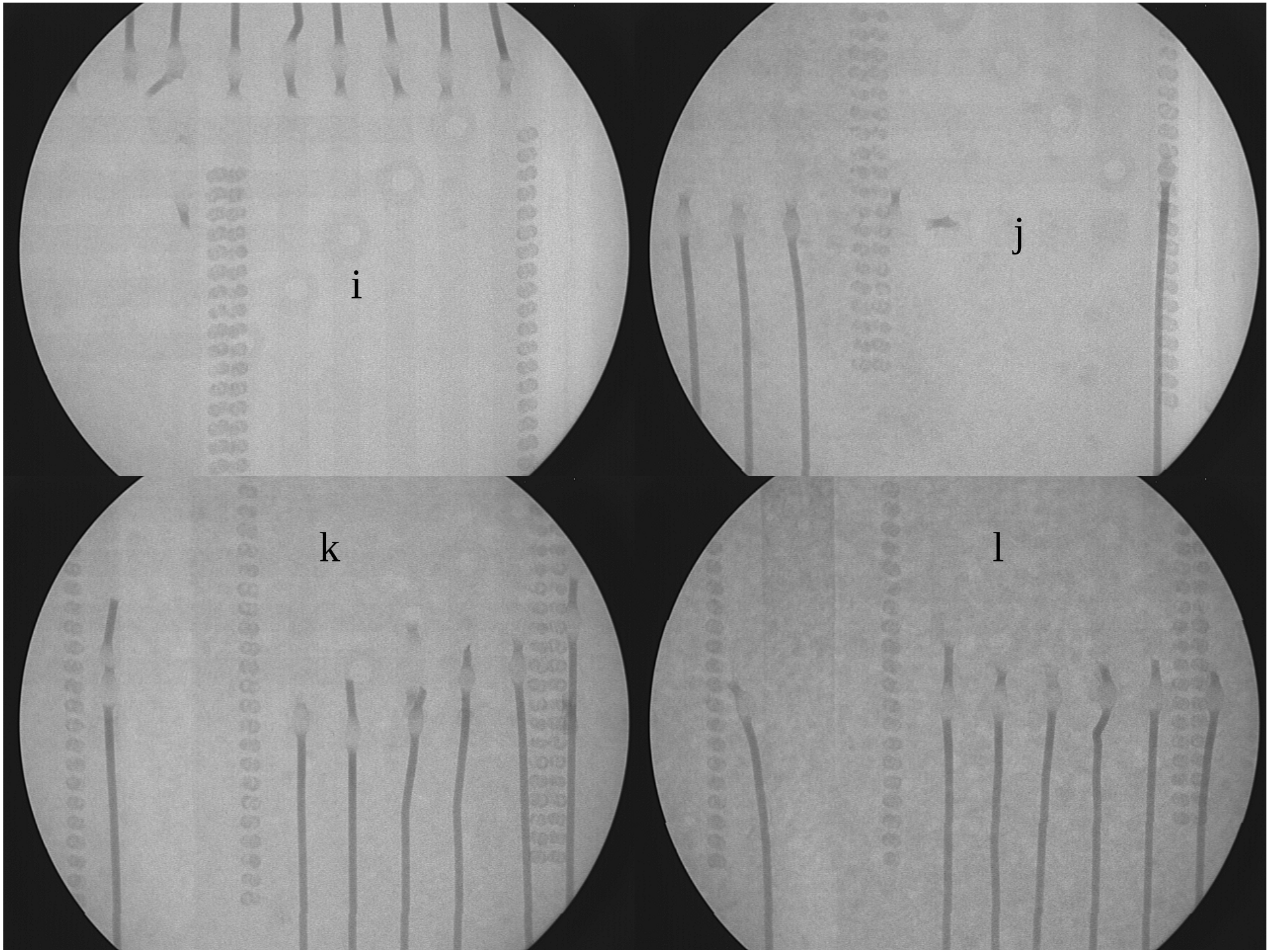
X-Ray of M2

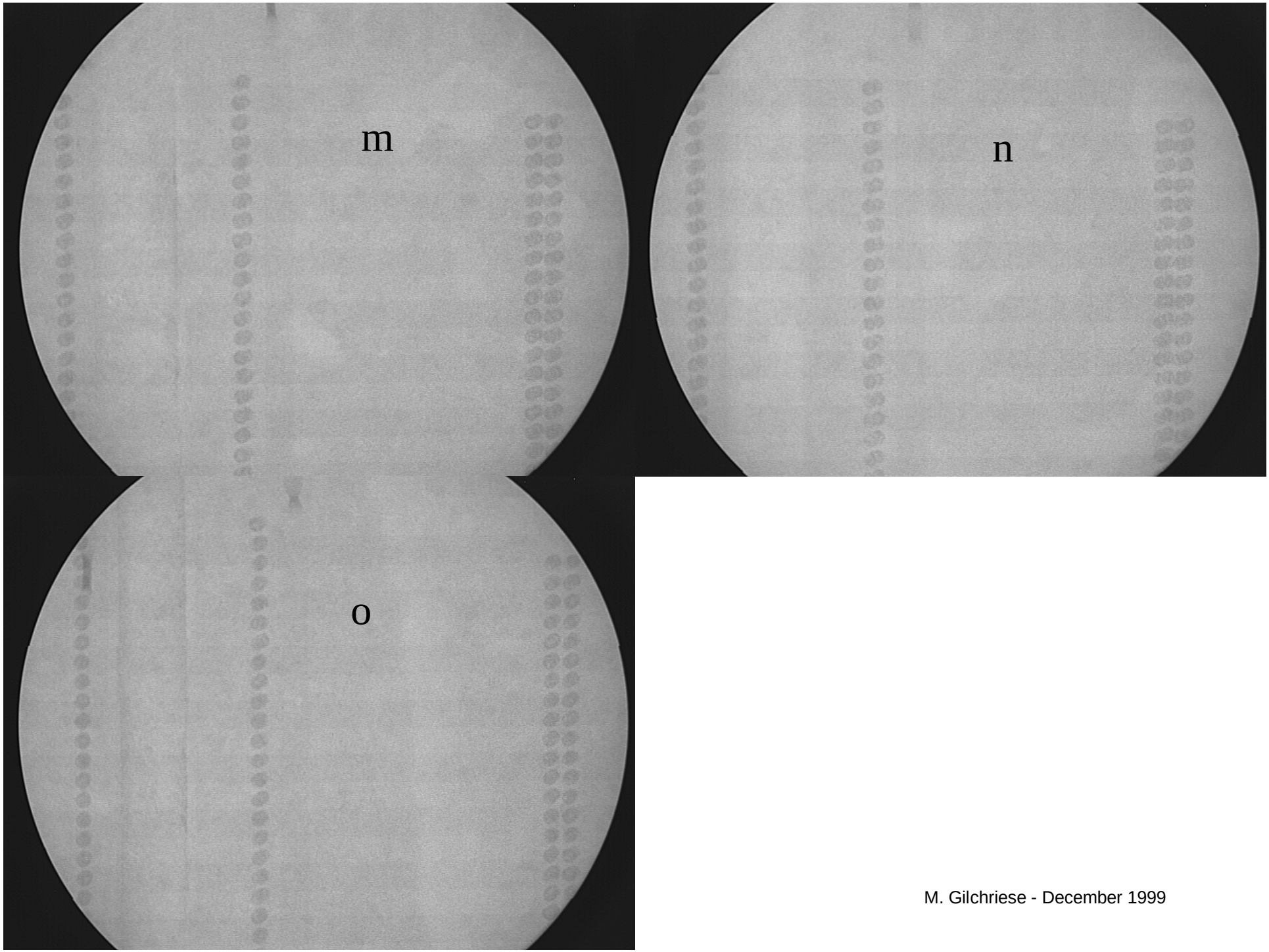


- ICs disconnected - last four on both ends. All chips operated OK initial. Later failure.
- Supposition is CTE mismatch from gluing to Al support plate, followed by creep from sufficient shear forces to finally cause joints to break near ends.
- Photos clearly show greater displacement near ends.


a
b
c
d


e
f
g
h


i
j
k
l



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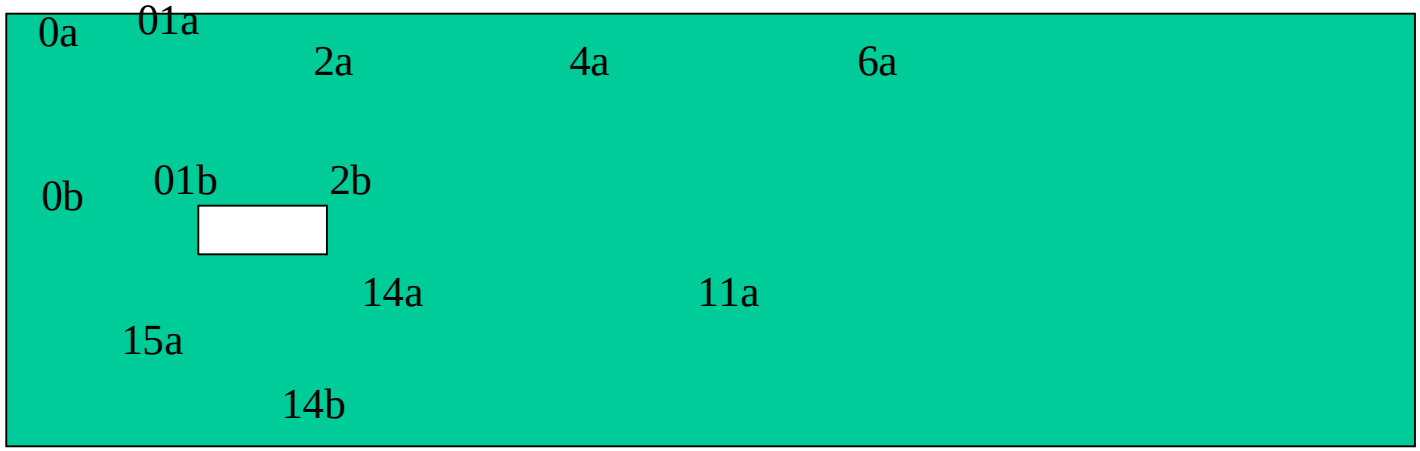
How Did This Happen?

- Scenario
  - Module attached to aluminum plate with conducting epoxy
  - Epoxy sets at about 60-80^{o}C, firmly attaching chips to aluminum
  - Cool down, aluminum shrinks more than silicon, putting shear stress on bump bonds that induces creep
  - Creep is a complicated subject, but to the extent I understand this, one can, for example, define a time to failure under constant stress eg by* time to failure in hours at 20^{o}C = $10^{-[\text{stress(in MPa)} - 13.2]/3.47}$ which yields about 120 days at a stress of 1 MPa. I'm not claiming this is the correct formula, only that qualitatively one can understand what happened to explain working initially and then failure.

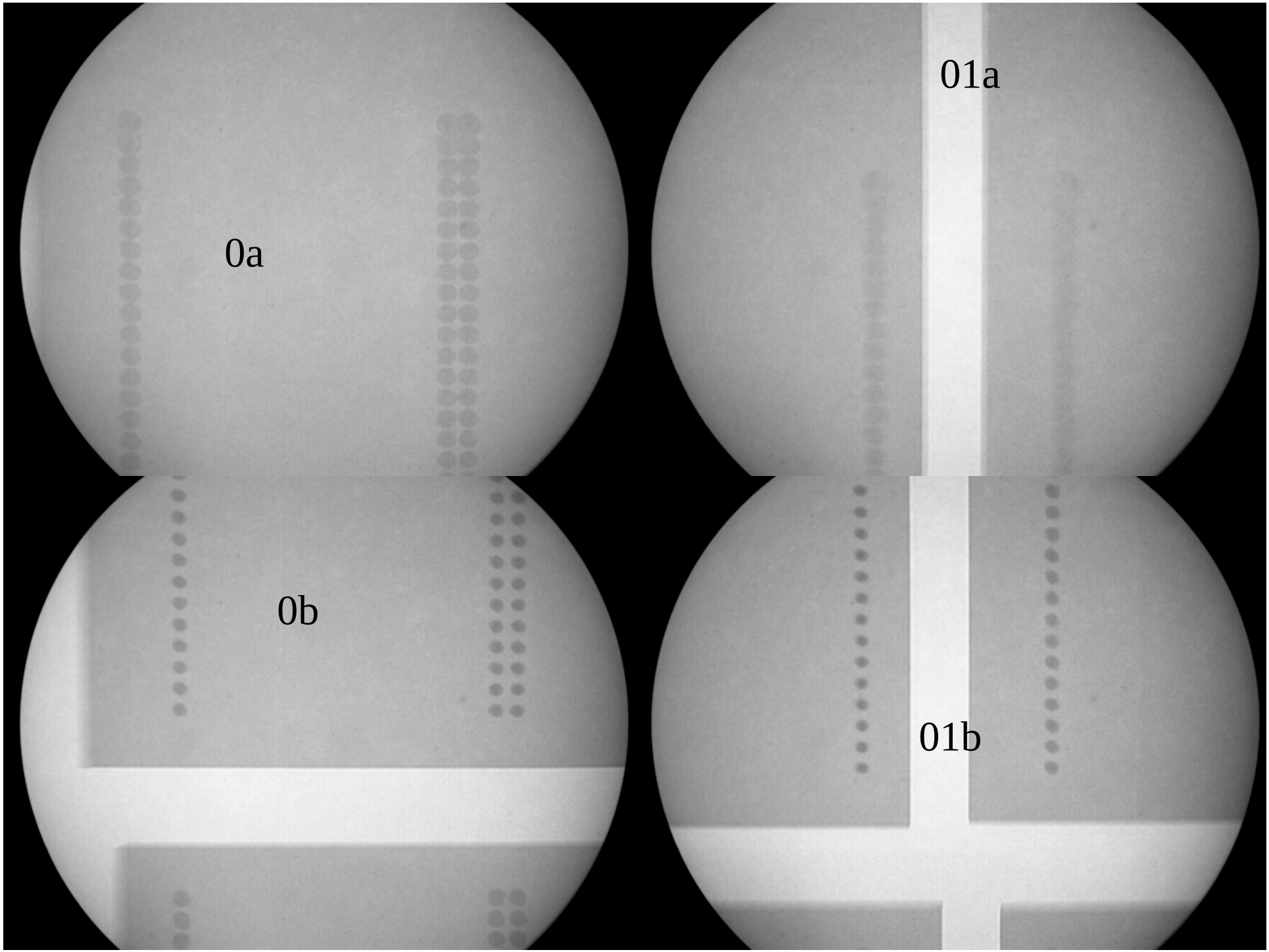
* Solder Joint Reliability of BGA, CSP, Flip Chip and Fine Pitch SMT Assemblies, J. Lau and Y-H Pao, pg.122

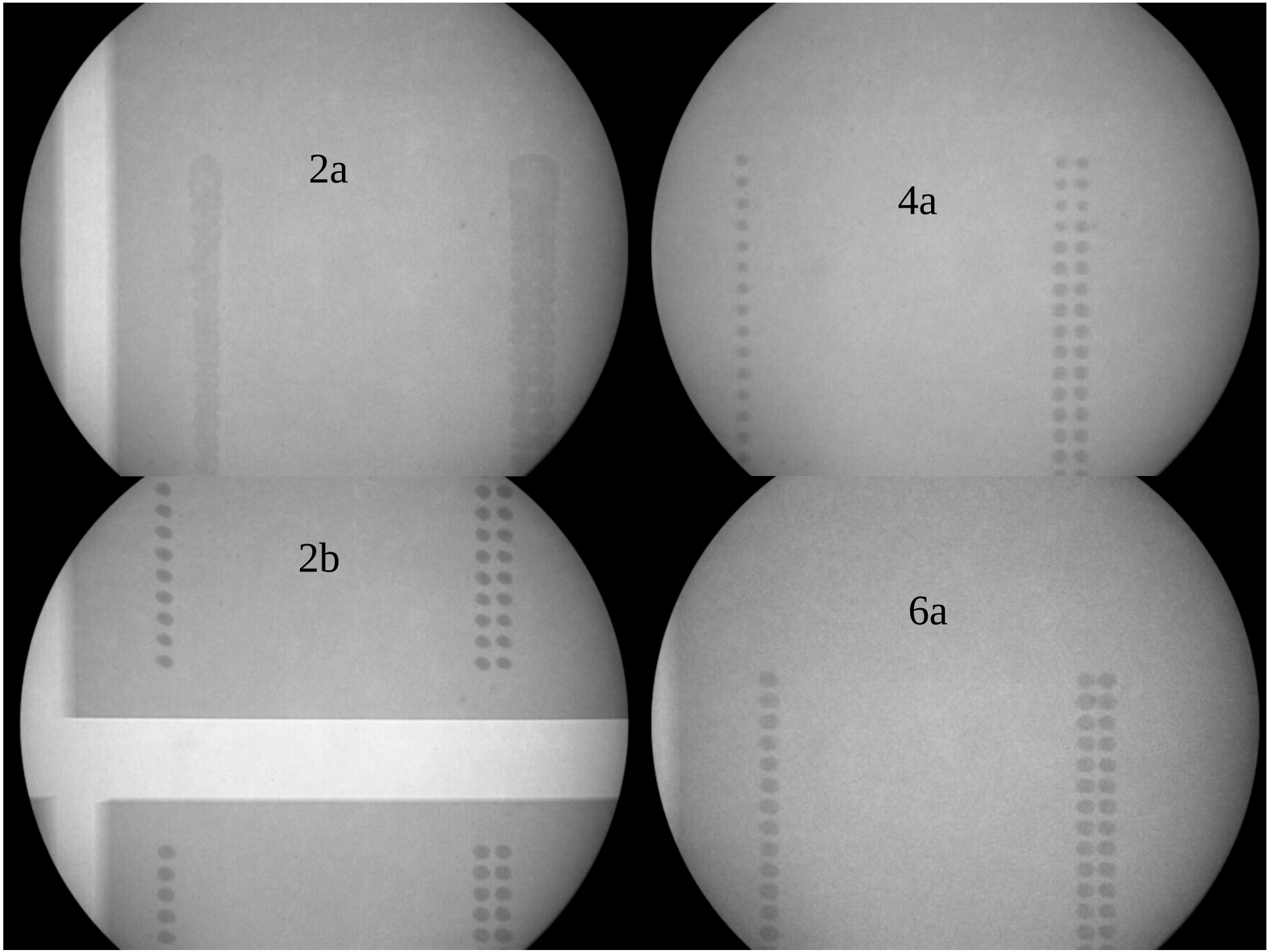
X-Ray Alenia Module 3135-08

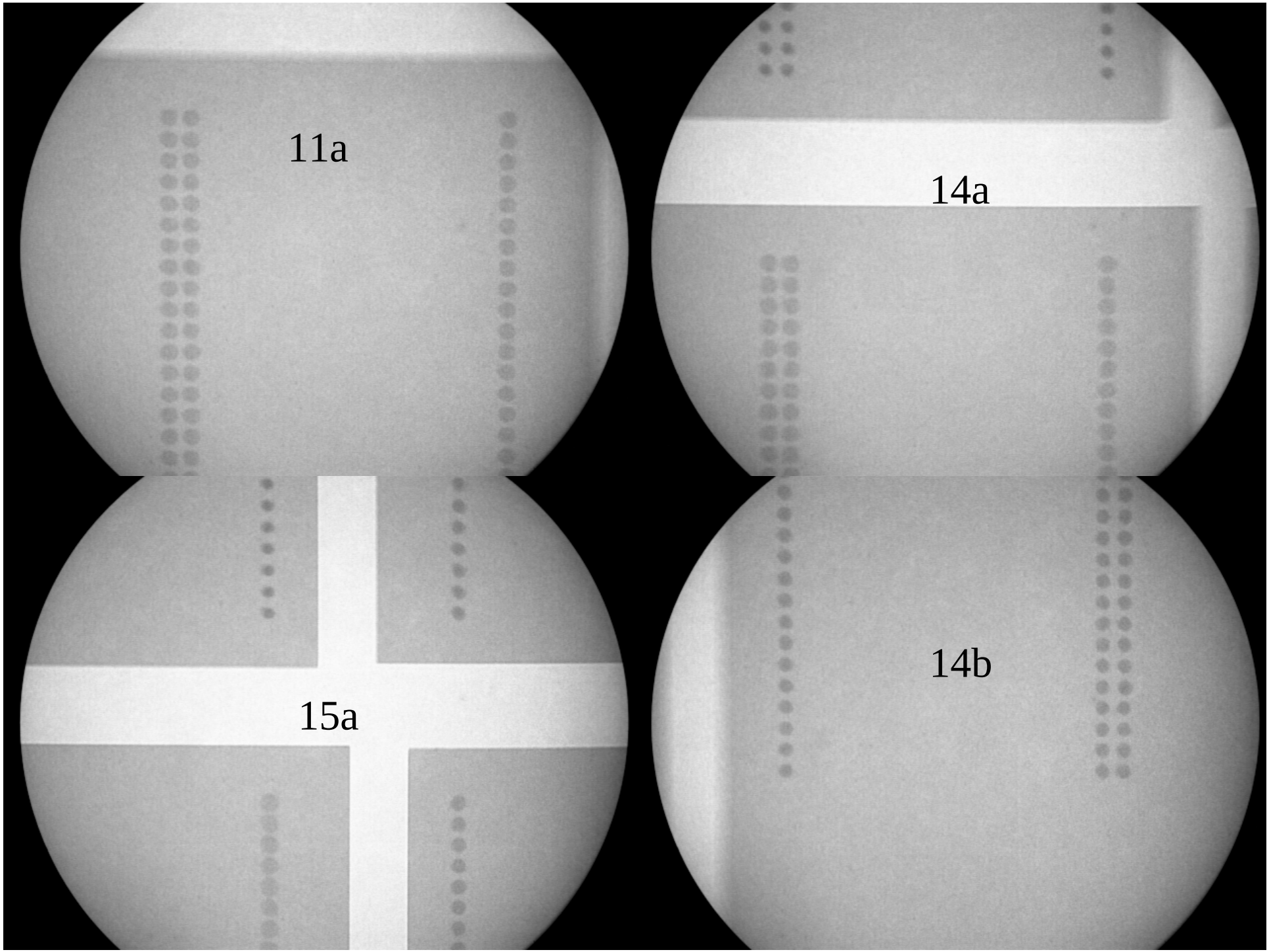
Looking down on backside of sensor.
First module assembled by Alenia. Not bad for first try



- Chips 0, 1, 2 and part of 3 show uneven pressure - more outside edge, less middle
- In general other chips look pretty good, although there is some variation of pressure as can be seen in photos.


0a
01a
0b
01b

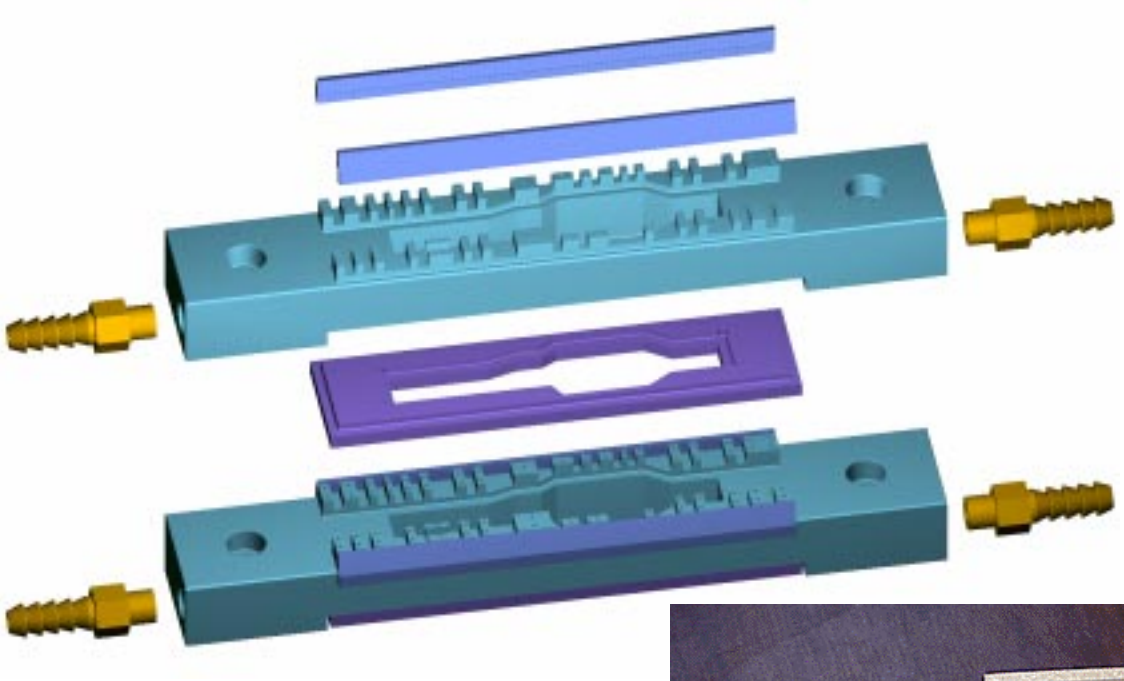

2a
4a
2b
6a

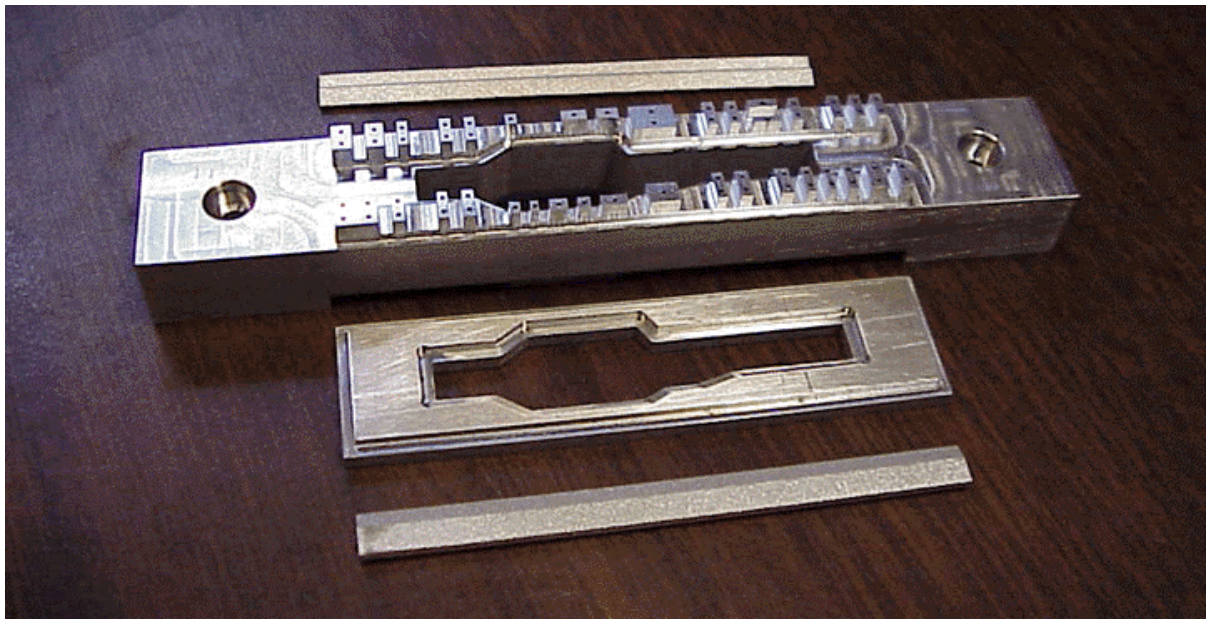

11a
14a
15a
14b

Module Assembly/Placement Status

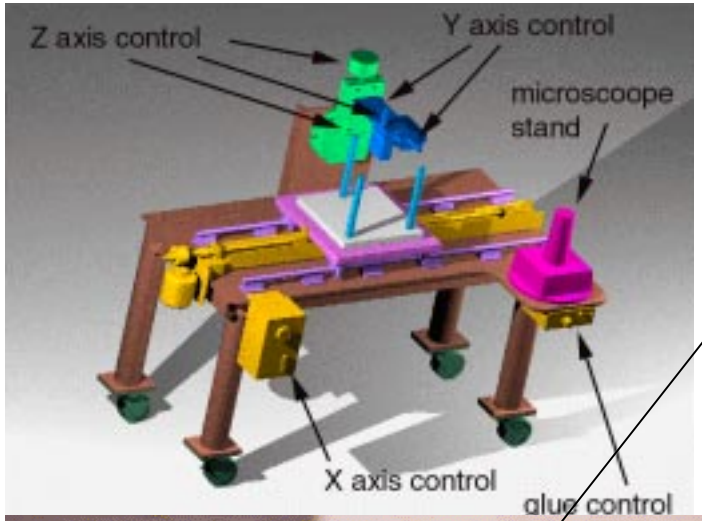
- I'm reporting on the work of mostly Fred Goozen at LBL. See his Web Pages http://pxs.lbl.gov/~goozen/INDEX.html
- Since September
  - Measurements of deflection resulting from CTE mismatch of flex and silicon.
  - Completion of precision glue machine and started using this for tests of attaching flex to modules
    - Practice process, using custom vacuum chuck, etc
    - Make test vehicles to get started on automated wire bonding tests at LBNL and Ohio State
  - Modest revisions to conceptual design for placing modules on sectors
    - Tooling fabrication on hold until really freeze sector design/layout
    - However, aim to begin practicing simple placement on carbon-carbon and establishing survey techniques.

Custom Vacuum Chuck

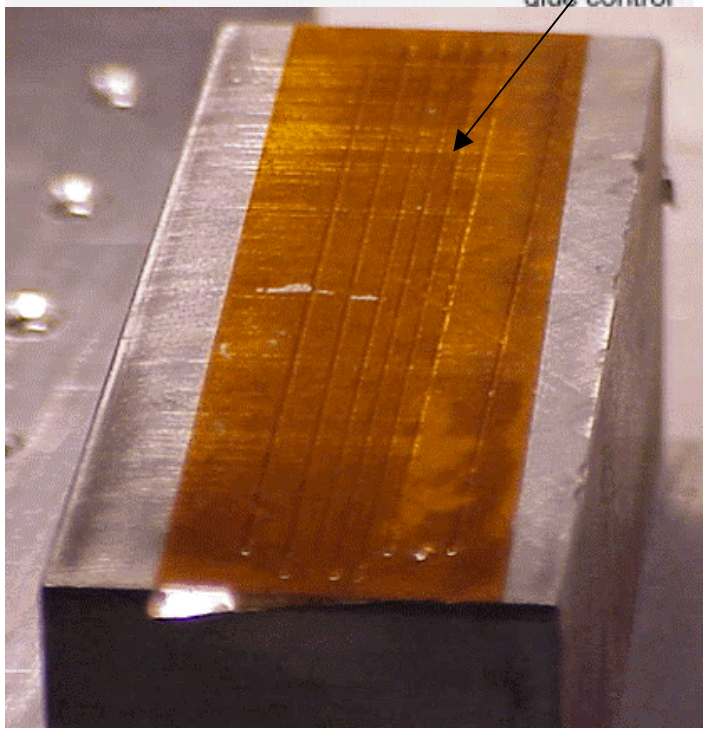


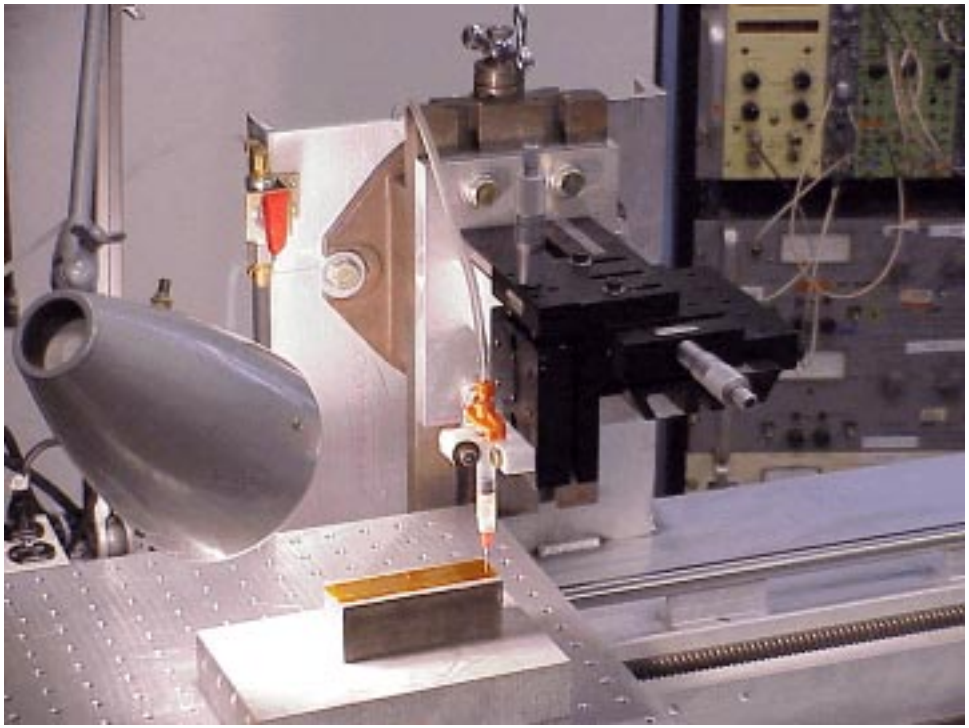


Glue Dispensing Table

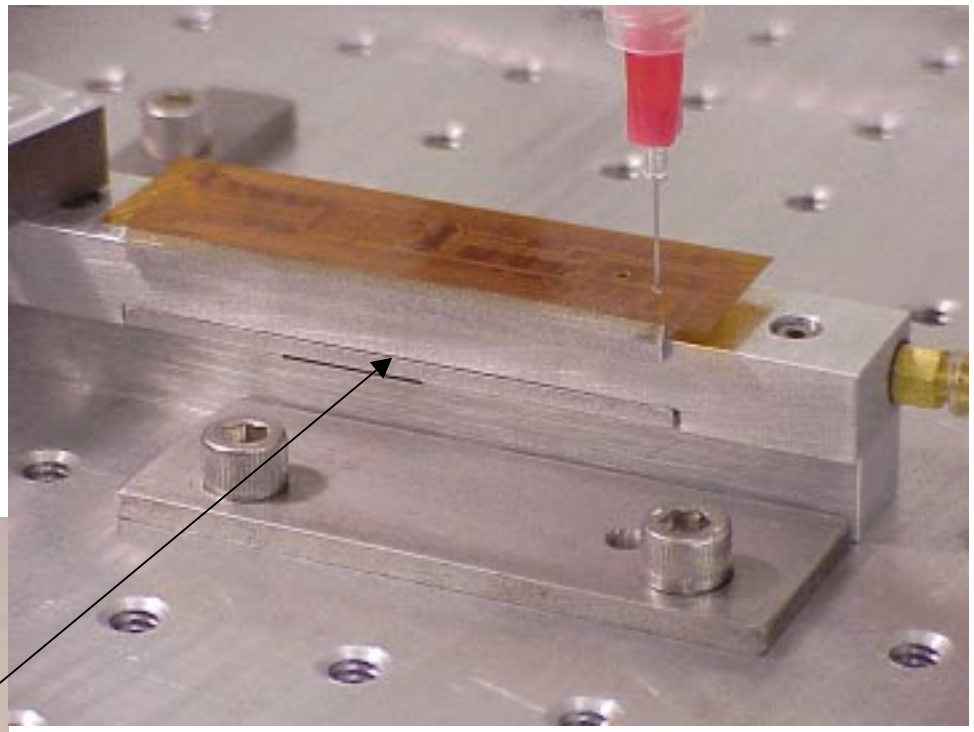


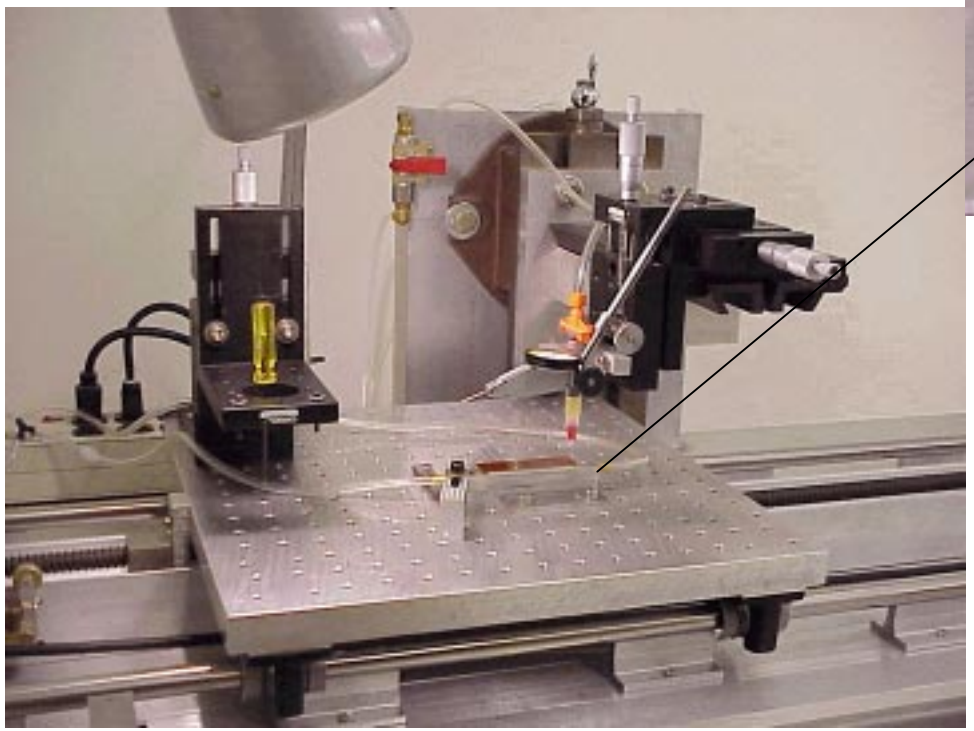
- Operational
- Appear to be able to have good control, at least with Araldite 2011.





First Trials with Real Flex and Vacuum Chuck





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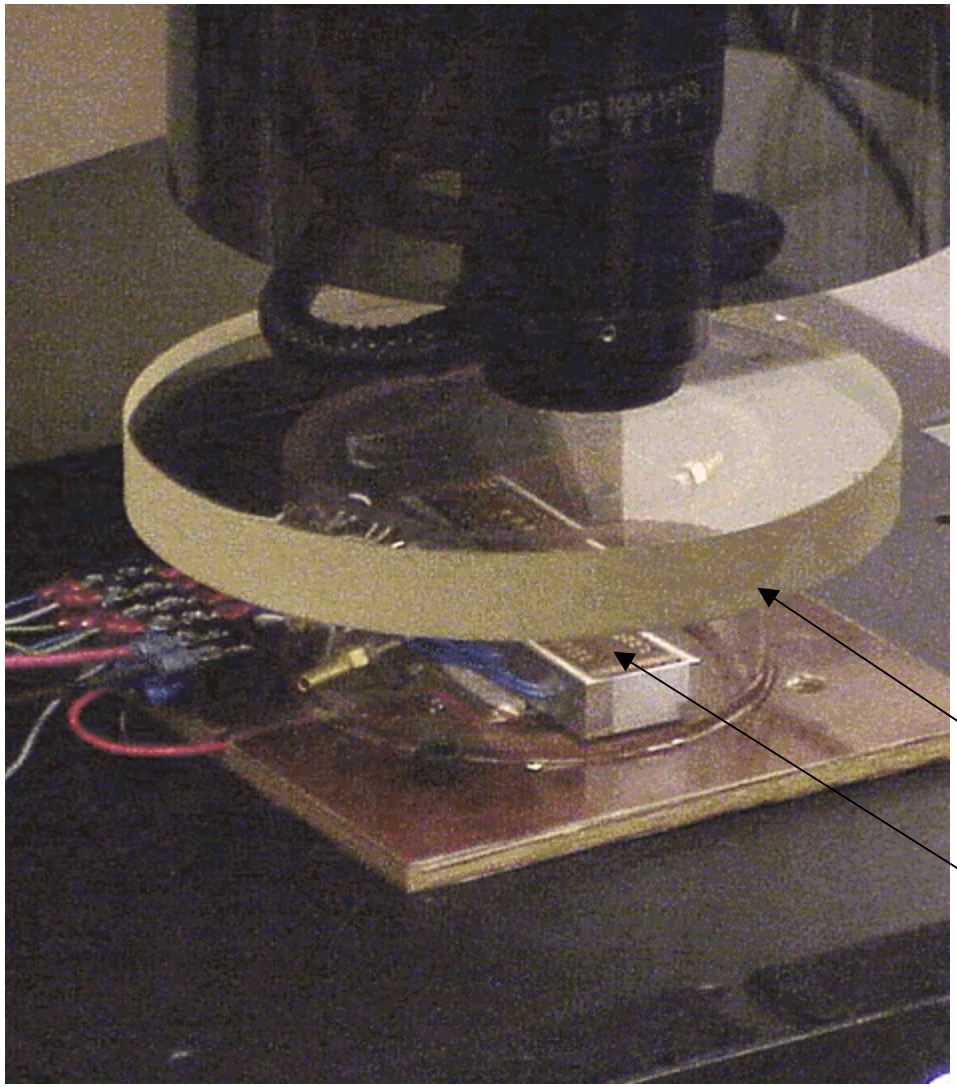
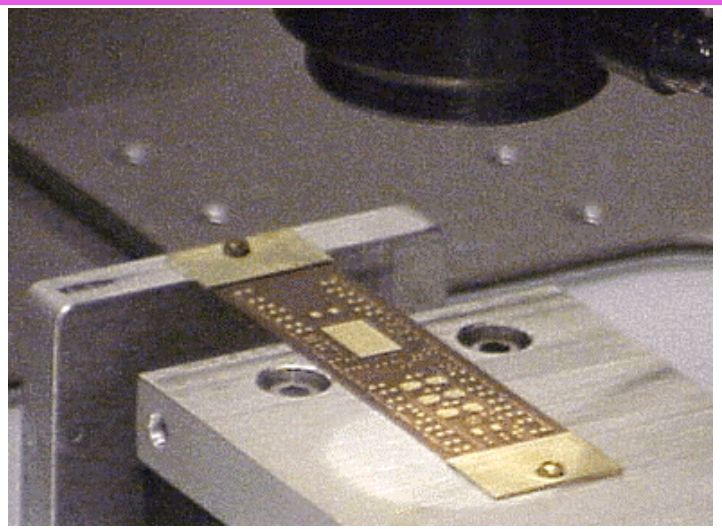
Measure Flex Deflections

SmartScope



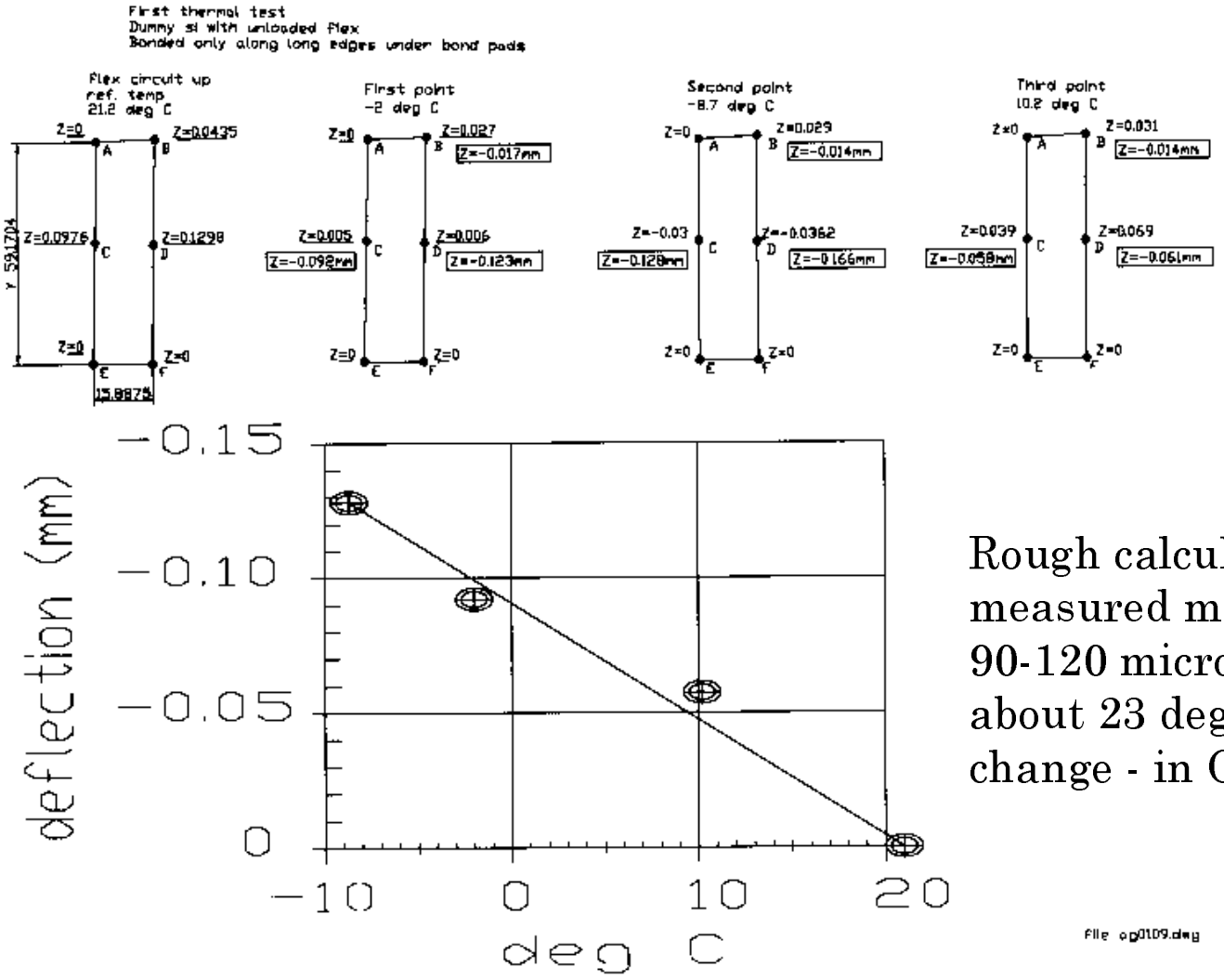


Measure modulus of flex directly and find value of 288,000 psi. Kapton varies but can be 350,00-450,000.

Cold chamber

Flex glued to 300 micron silicon. Targets on flex to measure height.

Deflection of Flex Attached to 300 microns of Silicon

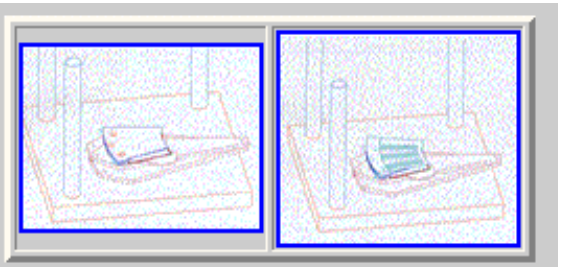


Rough calculations(W. Miller) using measured modulus predicts 90-120 micron deflection for about 23 degree temperature change - in OK agreement.

What Does This Mean?

- Deflection will depend on thickness and material of flex hybrid and final thickness of detector + ICs.
- Must also take into account tile/wafer bow also.
- Worst case, perhaps ends of module 150 microns higher than middle, unless held down => must be held down
- This introduces forces on bump bonds albeit small ones.
- Don’t have complete answer - need more measurements with dummy modules and analysis.
- Worst case - must tack with glue both ICs(easy) AND sensor at ends - not so easy.

Module Attachment Status

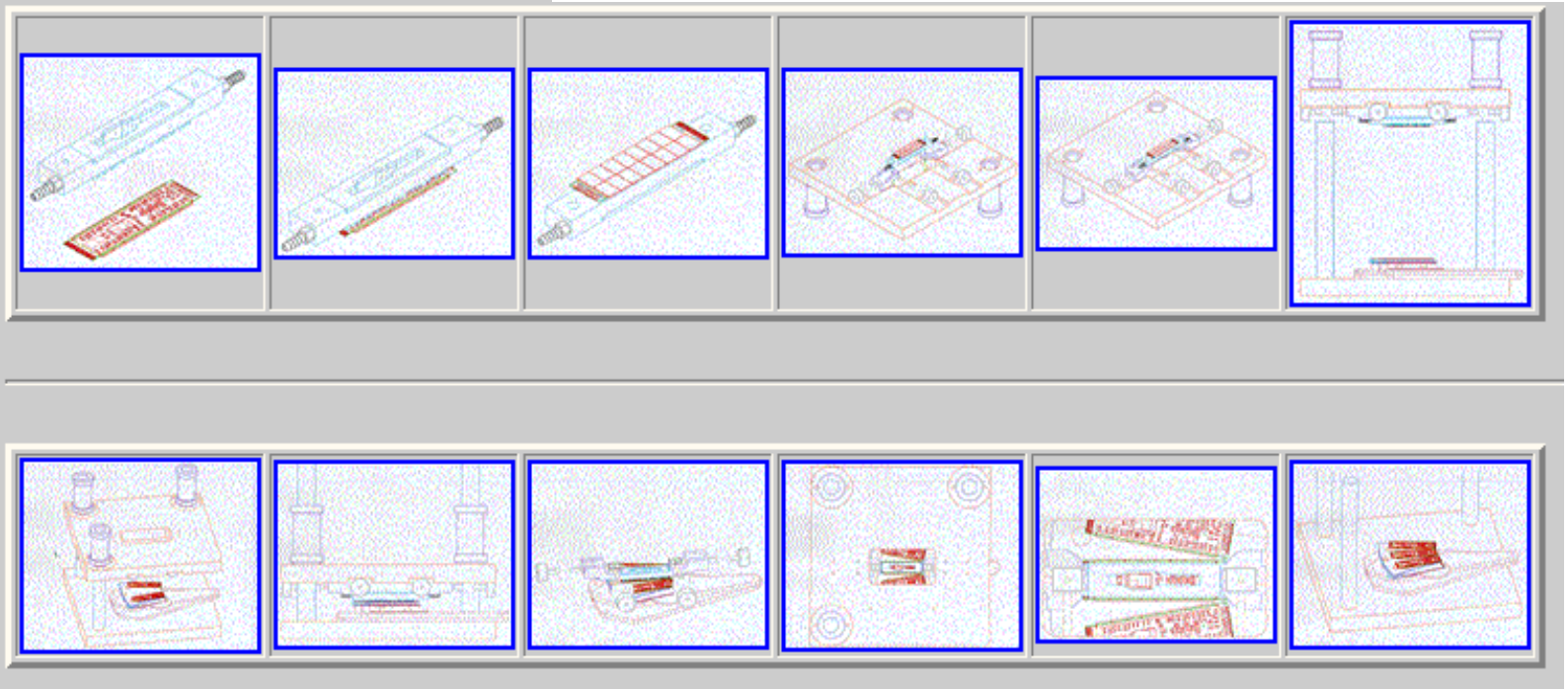


Concept still the same and some pictures may be found at

http://pxs.lbl.gov/~goozen/assdetset.html

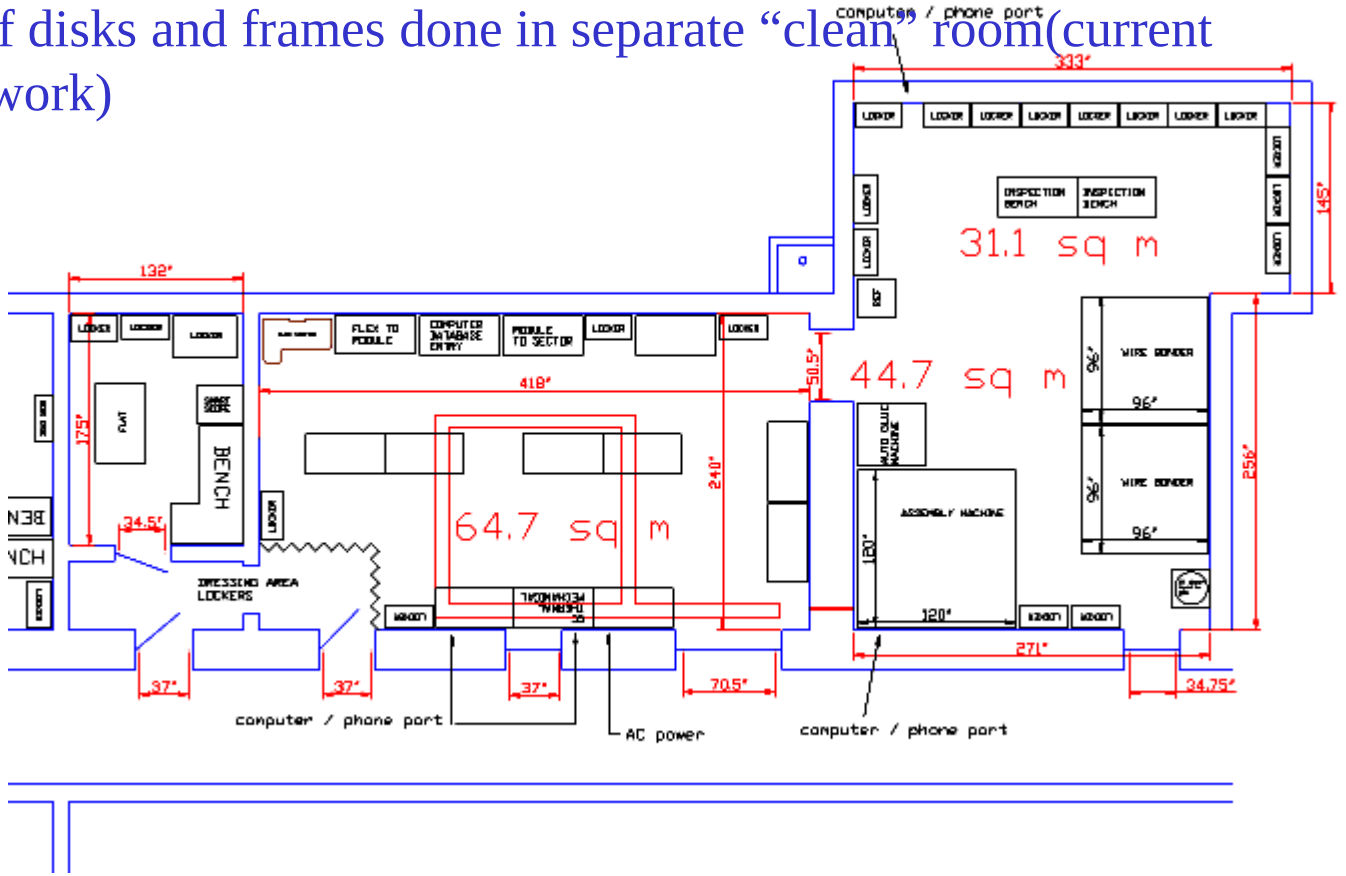
Immediate plan is to practice gluing with flex-on-silicon and vacuum chuck to carbon-carbon with CGL and measuring height uniformity, location version time, etc

We plan tooling fabrication start February next year - NEED FROZEN LAYOUT



Clean Facilities

- All module mechanical fabrication and attachment to sectors done in new “clean” facility. Ready and equipment being installed(slowly)
- Electrical testing done in separate location(current location)
- Final assembly of disks and frames done in separate “clean” room(current location for this work)



Module Assembly/Attach Clean Room on November 18